Cellular Respiration Lab

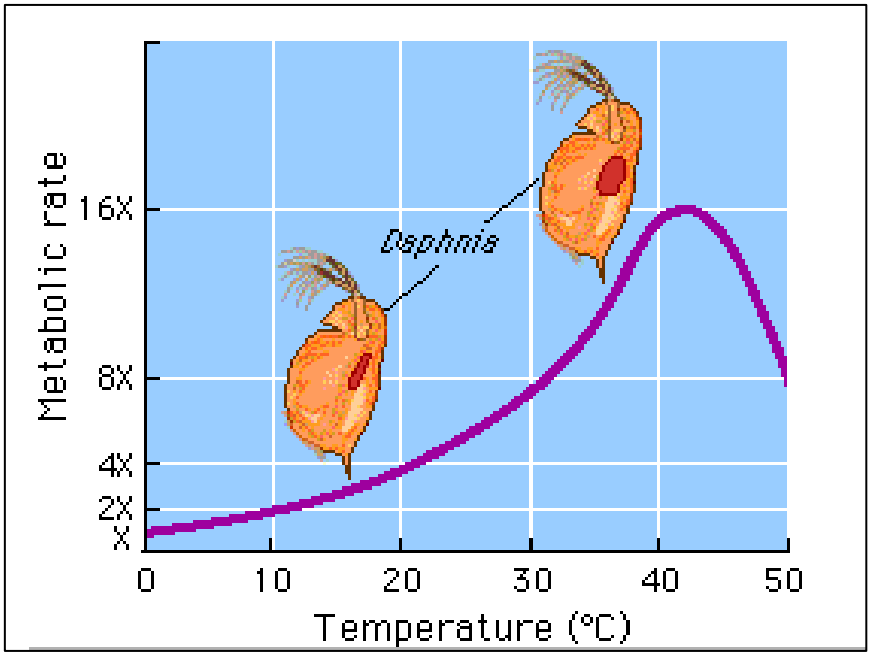
Cell respiration is the process by which organisms catabolize organic molecules into the more efficient ATP molecule that can be used to power nearly all biological processes. In most organisms oxygen is used to oxidize (extract energy-rich electrons) these organic molecules and carbon dioxide is released as a byproduct when the organic molecules are oxidized. Oxygen then combines with available hydrogens to form water as another waste product. The overall equation for this reaction is shown below:

$$C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O + 686 \text{ kilocalories of energy/mole of glucose oxidized}$$

Although the terms **ectotherm** and **endotherm** are usually used to describe *animal* body temperature regulation, they can also be used to describe plants. Most plants cannot regulate their body temperature internally and are therefore at the mercy of their surroundings to absorb heat energy to assist cellular processes. There is a relationship between metabolic rate and temperature called Q_{10} – The Temperature Coefficient. Simply stated, **for every 10°C change in temperature, a corresponding change in metabolic rate occurs. The change factor (Q_{10}) is usually 2-3 in biological systems**. An example is shown below:

The invertebrate crustacean *Daphnia magnum* has a Q_{10} of about 2 meaning that for every 10°C increase in temperature, its metabolic rate increases by a factor of 2. Notice however this only occurs up to a certain temperature. **Explain this observation.**

$$Q_{10} = \left(\frac{R_2}{R_1}\right)^{\left(\frac{10}{T_2 - T_1}\right)}$$



Assume that **X = 1** in the graph data.
Use the data to show your calculation of the Q_{10} value for *Daphnia* between 20 & 30°C (T2 = higher temperature & T1 = lower temperature, R2 = metabolic rate at T2, R1 = metabolic rate at T1)

How might this data differ for an endotherm such as a mouse?

The purpose of this experiment is to determine if metabolic rate in ectotherm fish will change based on temperature and if so whether or not it follows the Q_{10} rule.

Write a null hypothesis appropriate for the first part of the purpose. How will it be tested and how will you determine if fish follow the Q_{10} rule?

Methods

Your group will measure respiration rate based on oxygen consumed over time using a dissolved oxygen sensor. There is only 1 sensor so make sure to collaborate about each group's timing of using it so all groups can obtain data in the time allotted. You must read the methods & construct appropriate data tables for data collection during the lab. The basic procedures are described below:

1. Obtain an experimental chamber with a fish, a larger contain with water & a cup of ice.
2. Place the fish container into the water container and let stand for 5 minutes.
3. Record an oxygen reading with units shown on meter & record the temperature in Celsius.
4. After 5-10 minutes, record the oxygen & temperature again.
5. Calculate the respiration rate for this temperature condition.
6. Remove the fish container from the water and set aside on lab table.
7. Add ice to the water container so that it is precisely 10 degrees lower than the first temperature reading.
8. Replace the fish container back into the water container with ice and let stand 5 minutes. **During this time, add ice as needed to maintain a constant temperature…but add slowly so it does not become too cold** because you have no means to warm it back up.
9. Record an oxygen reading with units shown on meter & record the temperature in Celsius. **During your next time frame, add ice as needed to maintain a constant temperature**
10. After 5-10 minutes, record the oxygen & temperature again.
11. Calculate the respiration rate for this temperature condition.

Statistical Analysis

You should now have the respiration rate for two different temperatures. Record the data for all other groups to enter into the t-test website. The room temperature values should be input into the first box and the cold temperature values should be input into the second box. The p-value should be used to reject or accept your null hypothesis. You can also obtain the standard deviation to calculate standard error for error bars on your figure.

Questions that should be addressed in your report:

What controls were implemented to maintain good results?
What were the dependent & independent variables?
How does this data provide useful information?
What errors may have occurred?
What are some extensions that could be done?

Construct a formal lab report according to the general guidelines for submission by the specified due date shown on the calendar.